

Newer Concepts of Anatomy of the Lungs

Advantages to Surgeons, Internists, Bronchoscopists and Radiologists

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SUMMARY

In the newer concept of the anatomical divisions of the lungs, the bronchopulmonary segment is the primary unit. Specific lung areas are identified by their relationship to the branch of the bronchus that serves them. The left upper lobe apical segment, for example, is that which is supplied by the left upper lobe apical bronchus. The boundaries of the segments are definitive; thin tissue surrounds each segment.

Some diseases of the lungs tend to progress only "through channels"—reaching a segment via the specific airway serving it, and then frequently remaining within the segmental boundaries.

The concept is of particular importance to surgeons because of the trend toward segmental resection and salvage of vital lung tissue. In addition, a more definitive nomenclature, useful to surgeons, internists, radiologists and bronchoscopists in designating the location of a lesion or a foreign body, is possible.

THE recent rapid advances made by thoracic surgeons upon problems relating to segmental pulmonary operations have virtually forced the entire medical profession, including clinical anatomists, to take stock of the present knowledge of anatomy of the lungs. Despite the great forward strides in the direction of more accurate diagnosis and surgical treatment of thoracic lesions during the past decade, it was not until the period immediately following World War II that the present newer concepts of pulmonary segmental anatomy began to be formulated. Owing primarily to the investigations and writings of Huber, Churchill, and the Macklins, and, in addition, to the incessant demand of surgeons, great interest has been taken in the field of pulmonary anatomy and revolutionary changes have been wrought. The fundamental concept, which is responsible for the pronounced change in ideas on pulmonary structure, is, in Huber's words, that "the lung in its ultimate analysis is the complete and total branching of the bronchus leading to the lung."

This new idea of the predominance of the bronchus and of its major branches immediately chal-

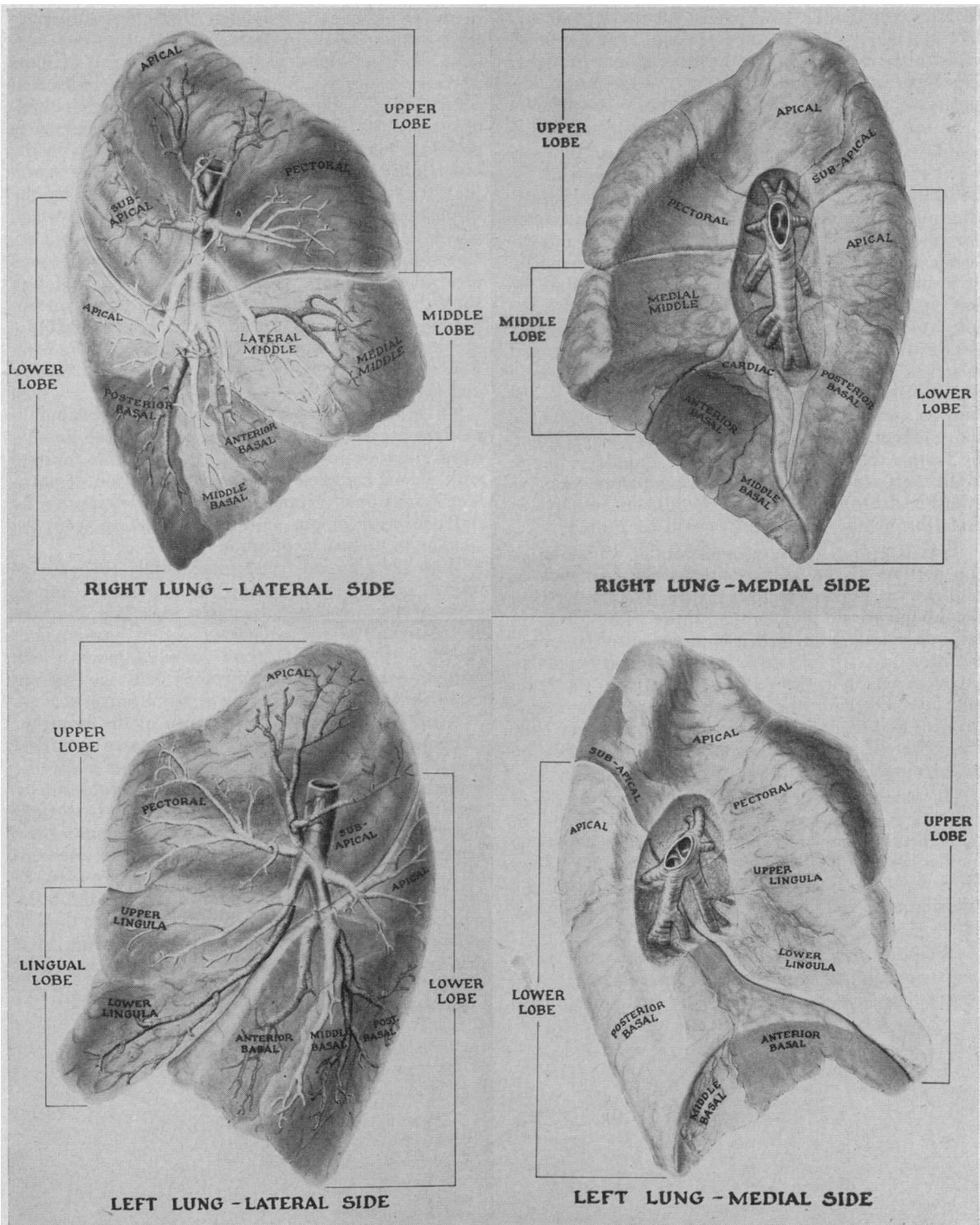
lenges the position of the lobe as the primary anatomical unit and brings to the fore the bronchopulmonary segment as the functional pulmonary unit. In order to visualize properly the lung from the point of view of its divisions into bronchopulmonary segments, it is necessary first to modify, if not abandon, the usual concept of a tri-lobed right lung and a bi-lobed left lung. This concept of lobar divisions is based, anatomically, solely upon the presence of the surface fissures, which are but supposititious indications of the fundamental underlying structure. Instead, in order to reorient thinking to the bronchopulmonary plane, physicians must train themselves to visualize the anatomy of the main stem right and left bronchi and their major branches.

Physicians who are unaware of the basis for bronchopulmonary segmental anatomy should take note of the experimental work in which it was observed that the injection of colored gelatin or air into the bronchial subdivision in question filled only the bronchopulmonary division served. Injection very satisfactorily delineates the boundaries of these divisions. Furthermore, with careful technique it is possible to dissect out the thin connective tissue planes between the various bronchopulmonary segments. Finally it is a commonly known anatomical fact that the normal as well as the accessory pulmonary fissures lie in the planes between the bronchopulmonary subdivisions.

The branching of the main stem bronchi and their development into the bronchopulmonary segments may be observed by starting at the main stem bronchus just below the tracheal bifurcation and following the entire bronchial course. The right main stem bronchus has three main branches, one each for the upper, the middle and the lower lobe. The branch for the lower lobe is actually a continuation of the main stem bronchus inferiorly into the lower lobe. The right upper lobe bronchus subdivides into three distinct branches to establish the apical, the sub-apical, and the pectoral divisions of the lobe. The bronchus to the right middle lobe divides into two branches, one for the lateral middle and one for the medial middle segments. It should be noted that the two divisions of the right medial lobe lie in a plane lateral and medial to one another; it is in this area only that a fundamental distinction exists between the right and left lungs. The continuation of the right main stem bronchus into the lower lobe gives off an upper branch to the apical segment of this lobe. The remainder of the bronchus subdivides into branches, one each to the anterior, middle and posterior basal portions of the lobe, and another to the cardiac segment of the lower lobe.

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In following the course of the main stem bronchus of the left lung, it will be noted that the main branch to the left upper lobe subdivides into two branches. One of these goes to the portion of the left upper lobe corresponding to the right upper lobe. The other branch is for the lingula, or that portion of the left upper lobe which corresponds to and is the

homologue of the right middle lobe. The upper of these branches has three main divisions establishing the pectoral, the apical, and the subapical segments. The lower branch divides into two branches, one to the upper and the other to the lower lingula. Thus, the two segments of the lingula lie superior and inferior, one to the other, unlike the segments

of the right middle lobe which occupy medial and lateral positions. The main continuation of the bronchus to the left lower lobe breaks up into branches like those on the right, which run to the apical, the posterior, the middle, and the anterior basal lobes.

It would be well to have a nomenclature that would indicate the relationship between the segment of the lobe in question and the branch of the bronchus supplying it. This would considerably diminish the number of anatomical terms and make for easier understanding of the relationship and the locale of the segment and the bronchus referred to. It would be convenient to say, for example, that the left upper lobe apical segment is supplied by the left upper lobe apical bronchus; the bronchus would derive its name from the bronchopulmonary segment it serves and the bronchopulmonary segment would derive its name from its position in the lung as the lung is viewed from a medial or a lateral plane. In like manner, the left lower lingula bronchus would be known to supply the left lower lingula segment. With such a nomenclature, such confusing terms as epiarterial bronchus, cardiac stem bronchus, hyparterial bronchus, and others, would be avoided.

It is true that there is considerable variation of the pattern of the bronchopulmonary segments as outlined in preceding paragraphs. However, these deviations are no greater than those which occur in any other well delineated and pictorialized anatomical areas, as, for instance, in the arterial supply to the stomach or in the venous return from the scalp and face. Certainly the largest structures, the major bronchi and their major branches, deviate very little from charted pattern either as to the site of division or the number of divisions.

(It is noteworthy that there is a higher degree of constancy of pattern in all the main branches of both the right and left upper bronchi than there is in the lower lobe bronchi, particularly that group of lower lobe bronchial branches running to the anterior, the middle and the posterior basal segments.)

Obviously this newer concept of pulmonary anatomy is of clinical importance to internists, to bronchoscopists, and to surgeons who are called upon

to resect pulmonary segments. Radiologists already have profited in many instances from this new concept, for it is helpful in stating the location of spots or areas of disease. A report that there is indication of pathologic change in a specific bronchopulmonary segment or perhaps in adjoining segments is certainly more accurate than reports written in the older lobar terms could be. It is possible, for example, to give the location of atelectatic areas by the bronchopulmonary segment in which they occur, which in a large number of cases will be the full extent of the lesion. This is true also of the newer groups of viral pneumonia, in which the lesions, although spotty and scattered, tend to stay within bronchopulmonary segments. In addition, when a radiologist attempts to define for a bronchoscopist the location of a foreign body, he can do so more readily and accurately.

To bronchoscopists, the concept of bronchopulmonary segmentation and the more precise nomenclature are of further value. It is possible to state with almost complete accuracy the location of purulent lesions or of neoplastic tissue, as determined by the aspiration of pus or cellular secretion from the smaller bronchus in question.

With the surgical trend increasingly toward segmental pulmonary resection when possible, knowledge of the bronchopulmonary segments becomes imperative. The consequent saving of normal lung tissue, with attendant preservation of more nearly normal aeration and respiratory and mediastinal movement, is an outstanding surgical advance.

Another facet of the importance of the bronchopulmonary concept concerns the known predilection of various pathological processes for a specific bronchopulmonary area or areas. Tuberculosis favors the upper apical segment. Abscess is frequently observed in the apical and pectoral segments of the upper lobe and also in the posterior basal segment of the lower lobe. Bronchiectasis often involves the lower lobe on one or both sides, and in addition the neighboring part of the right middle lobe or the lingula division of the left upper lobe. Knowing what disease is most likely to occur in a given segment is useful in differential diagnosis.

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